Environmental Protection Agency

Dynamometer Calibration Verification Procedure

This procedure is written for the Environmental Protection Agency, National Vehicle and Fuel Emissions Laboratory (NVFEL) internal use. The use of specific brand names by NVFEL in this procedure are for reference only and are not an endorsement of those products. This document may be used for guidance by other laboratories.

NVFEL Reference Number

302E

Implementation Approval

Original Procedure Authorized on 08-16-82

Revision Description

(1) 11-25-96 The purpose of this change is to revise the procedure as described in EPCN #202.

Table of Contents

Attachments

1. Purpose

This procedure documents the calibration verification process of a Clayton ECE-50 dynamometer (dyno) as required by the Code of Federal Regulations. The verification involves making simple checks of the control and display functions and performing several coastdowns at different inertia weight (IW) and horsepower (hp) settings.

It is assumed that the dyno electronics have been calibrated as specified in the Clayton Instruction Manual and TP 207 and that the dynamometer power absorption unit has been calibrated according to TP 202.

2. Test Article Description

A Clayton ECE-50 direct drive, variable inertia (1000-6875 or 1000-8875 pounds in 125-pound increments) chassis dynamometer with Automatic Road Load Controller (ARLC) and digital display of horsepower and speed

Note: The Clayton circuitry was rewired at this facility so that indicated horsepower is based solely on front roll (FR) speed and torque, but the front/rear roll speed display can still be selected.

3. References

3.1 "Code of Federal Regulations," Part 40, Sections 86.116 and 86.118

3.2 "Clayton Instruction Manual R-8713"

3.3 "Proceedings of the Quality Control Symposium on Dynamometers," June 27, 1977, held at the Environmental Protection Agency (EPA)

3.4 EPA current safety policies

3.5 LabVIEW User's Manual

4. Required Equipment

4.1 Vehicle modified to perform coastdowns, fitted with a pneumatic lift controller (PLC) & "MECO" brake.

4.2 Master coastdown timer, cables, and the 60-tooth gear speed sensor assembly

Equipment used: Fabricated to specifications

4.3 Video Driver's Aid (VDA) System:

4.3.1 Data Acquisition Microcomputer

Equipment used: Apple Macintosh Plus Model #M0001A
Relax Technology 45 Megabyte Hard Disk Drive
Model #C46668

4.3.2 Video Monitor

Equipment used: Electrohome Electronics Model #38-V19NWB-AP

4.4 Compressed air supply with air hose, tire inflation chuck, and calibrated pressure gauge

4.5 Fixed speed cooling fan with a capacity not exceeding 5,300 cubic feet per minute (cfm).

4.6 Flexible exhaust tubes

Equipment used: Fabricated to meet requirements

4.7 Coastdown Computer, associated equipment, and software

Equipment used: Apple PowerMac 7100/66
National Instruments NB-MIO16 data acquisition cards
Dynamometer Verification Microsoft Excel Processor
LabVIEW Dyno Verification Application

4.8 Wireless Network System

Equipment used: Photonics Corporation, Cooperative® Transceivers and
Access/Power Unit

4.9 Uninterruptible Power Supply (UPS)

Equipment used: Controlled Power Company LT Series

4.10 Laboratory Network System (LNS)

4.11 Stroboscope

Equipment used: Pioneer Electric and Research Corporation Model DS 303

4.12 Calibrated digital multimeter

Equipment used: Fluke Model 8062

4.13 Twin-roll hydrokinetic dynamometer

Equipment used: Clayton ECE-50 with a power absorption unit to simulate the road load power and flywheels to simulate the vehicle's equivalent test weight

4.14 Butler Data Base

5. Precautions

5.1 The drive tires are inflated to 45 psig to protect them against damage from heat and distortion.

5.2 The cooling fan is operated within 12 inches of the vehicle radiator.

5.3 The vehicle exhaust is vented to the building exhaust scrubber system.

5.4 The coastdowns are performed immediately following a previous dyno check or a minimum of 10 minutes of dyno warmup to ensure dyno bearing friction stability.

5.5 The action of the vehicle lifting jacks is verified while the car is stopped. They should raise quickly but lower slowly.

5.6 The wheel chocks are removed and the exhaust connection and electrical lines to the vehicle are disconnected before the vehicle is removed from the dyno.

6. Visual Inspection

6.1 Verify that the dyno speed and torque meters read 00.0 ±0.1 when the car is off the dynamometer and the dyno roll brake is released. Notify the Calibration & Maintenance (C&M) senior technician if either the speed or torque meter reading exceeds ±0.1.

6.2 Other visual inspections are performed as part of the test procedure.

7. Test Article Preparation

7.1 Verify that the vehicle has a minimum of $^1/_2$ tank of fuel. If not, add sufficient fuel to obtain this level.

7.2 Ensure that the dyno roll brake is engaged.

7.3 Drive the vehicle onto the dynamometer, placing the drive wheels on the rolls. Leave the vehicle in neutral.

7.4 Connect the vehicle exhaust to the exhaust scrubber system.

7.5 Check and, if necessary, adjust the drive tire pressure to 45 psi.

7.6 On the dynamometer ARLC, set the IW to 6875 and set the thumbwheel (TW) to 10 hp.

7.7 Release the dyno roll brake.

7.8 Ensure that the correct IW are engaged and all flywheels turn together by lifting the dyno cage and rolling the flywheels with your foot.

7.9 Ensure that the front/rear roll switch is in the “Front Roll” position on the dyno speed/power display box.

7.10 Operate the vehicle in a forward gear momentarily until it is centered on the rolls. Stop the dyno rolls when the mark representing the 60-tooth-gear key position is at the top of the 2000 lb. weight. Verify that the drive tires have adequate side clearance from the dynamometer frame.

If the vehicle fails to center properly, notify the C&M senior technician.

7.11 Position the cooling fan within 12 inches of the vehicle radiator. Turn the cooling fan power on.

7.12 Place the wheel chocks in front and back of the non-drive wheels.

7.13 Switch on the PLC "MECO" brake.

7.14 Remove the air chuck, if necessary, and connect the compressed air line to the quick-connect under the vehicle rear bumper.

7.15 Remove the jack stand from the vehicle trunk, position it under the rear bumper, and raise the vehicle by pressing down on the jack foot pad sufficiently to allow you to push the lifting jack handles in the vehicle trunk down and insert the pins to hold them in place.

7.16 Remove the jack stand from under vehicle bumper.

7.17 Connect the UPS power plug to a 110-volt ac outlet.

7.18 Turn the UPS power on. The master coastdown timer and coastdown computer are powered by the UPS.

7.19 Look at the PLC inside the vehicle and verify that the following lights are illuminated:

"STANDS DOWN"

"AIR CHUCK ON"

"STANDS LOCKED"

If any of the lights are not illuminated, notify the C&M senior technician.

7.20 Press the PLC, "LIFT" button and verify that the drive wheels raise and clear the dyno rolls. If the drive wheels do not clear the dyno rolls, perform the following:

7.20.1 Press the "LOWER" button on the vehicle PLC.

7.20.2 Engage the dyno roll brake.

7.20.3 Reach under the vehicle and adjust the lifting jack pad by unscrewing it until it touches the floor.

7.20.4 Release the dyno roll brake.

7.20.5 Repeat Step 7.20 and, if necessary, Steps 7.20.1 through 7.20.4 one more time. If you are unable to obtain the proper clearance on the second attempt, notify the C&M senior technician.

7.21 Remove the 60-tooth gear, the associated key, and the T-handle hex wrench from the vehicle trunk. Place the key in the dyno shaft key-way, place the 60-tooth gear on the shaft, and align the key-way with the key. Press the gear into place and use the T-handle hex wrench to tighten the set screw. To prevent the 60-tooth gear from spinning, connect it to the roll cage using the attached elastic cord and clip.

7.22 Connect the "Data Acquisition Wire" from the master coastdown timer to the ARLC box.

7.23 Macintosh Operation

To operate the Mouse: Move the mouse around on a flat surface to position the pointer on the monitor screen. When you move the mouse, the pointer on the screen moves correspondingly.

To Click: Position the pointer on what you want to select or make active. Press and quickly release the mouse button.

To Double Click: Position the pointer on your selection. Press and release the mouse button twice in quick succession.

To Press: Position the pointer on a menu title. Without moving the mouse, press and hold the mouse button.

To Drag: Position the pointer on your selection. Press and hold down the mouse button and move the mouse. Release the mouse button.

Note: To operate the coastdown computer and the VDA systems, you may need to view MacAcademy's "Basic Macintosh" videotape, which is a self-taught course explaining the operation of the Macintosh personal computer.

7.24 Coastdown Computer System Operation:

7.24.1 Using the coastdown computer mouse, press on the Apple Icon and drag to "Chooser." Verify that the "AppleTalk" zones are visible.

If the "AppleTalk" zones do not appear, close the "Chooser," adjust the "Wireless Network System" transceiver by turning the knob on the inside of the vehicle roof, and repeat this step. If the "AppleTalk" zones do not appear, after a second attempt, notify the C&M senior technician.

Note: The "Wireless Network System" transceiver transmits and receives infrared signals between the coastdown computer and LNS in the vehicle test cells.

7.24.2 Double click on the "Dyno Verification" icon to open the "Dyno Verification" folder. See Attachment A, "Dyno Verification Computer Screen" which shows the front panel display used for dyno verification.

7.24.3 If it is not already selected, click on the arrow next to "Data Entry."

7.24.4 Click on the up/down arrows next to "Dyno" until the correct Dyno number is displayed.

7.24.5 Verify that today's "Date" and "Time" are set correctly.

If they are not, use the keyboard to enter the correct date and time in the corresponding fields.

7.24.6 Click on the up/down arrows next to "Tech ID" until your ID is displayed.

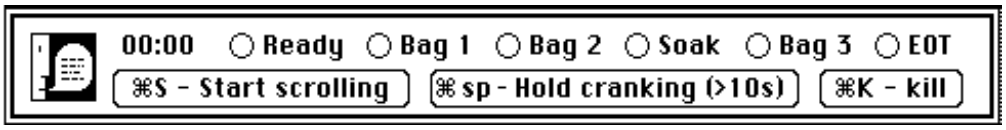
7.24.7 Verify that the "LabVIEW" run-arrow is in the run mode.

If it is not, click on the run-arrow in the upper left corner of the coastdown computer screen. The run-arrow will darken when "LabVIEW" is in the run mode.

7.25 VDA System Operation:

Three keyboard commands are used to control the VDA system during the engine starting procedure. Use <Command> in combination with the <S>, <Space Bar>, and <K>. The following is an example of the control dialog box as it will appear at the bottom of the VDA screen and a list of the different commands that may be displayed. The symbol for the command key is ⌘.

⌘ S	⌘ Space Bar	⌘ K
Start cranking	**Hold cranking**	**Kill**
Start scrolling	**Hold scrolling**	
Try again		



Control dialog box

7.25.1 To start the VDA, turn the video monitor power switch on.

7.25.2 Go to the control room and turn the “Computer Hard Disk” drive (lower unit) power switch on, wait 15 seconds, then turn the “Macintosh Computer” power switch on. The computer will beep and an icon representing a floppy disk will appear on the screen (see figure 1).

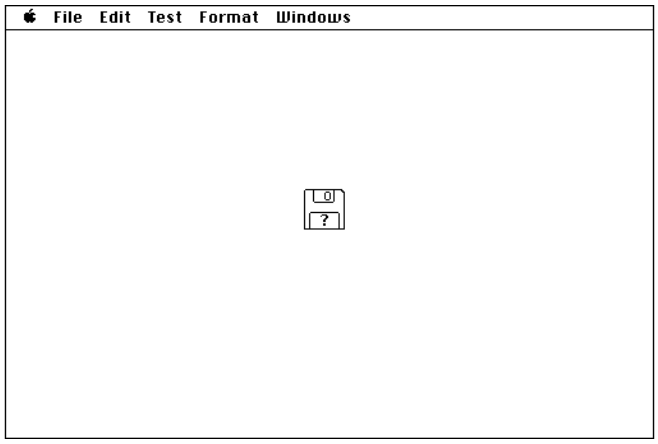


Figure 1

7.25.3 The message “Connect to the file server LNS Production Server as: Registered User” will appear (see figure 2). The dyno number will be displayed in the “Name” box. Type in the correct password and click on the “OK” button.

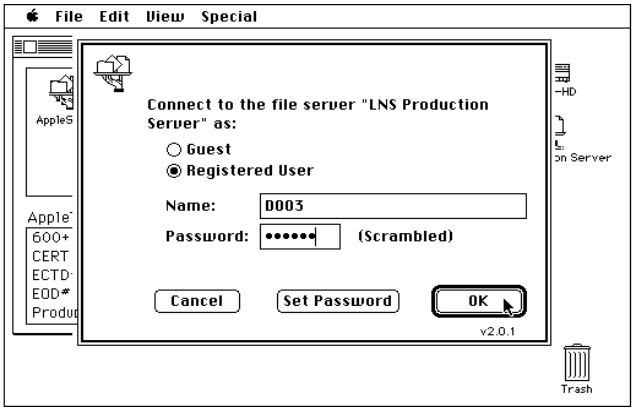


Figure 2

7.25.4 Double click on the “LNS Production Server” icon (see figure 3). The clock synchronization program will automatically set the clock.

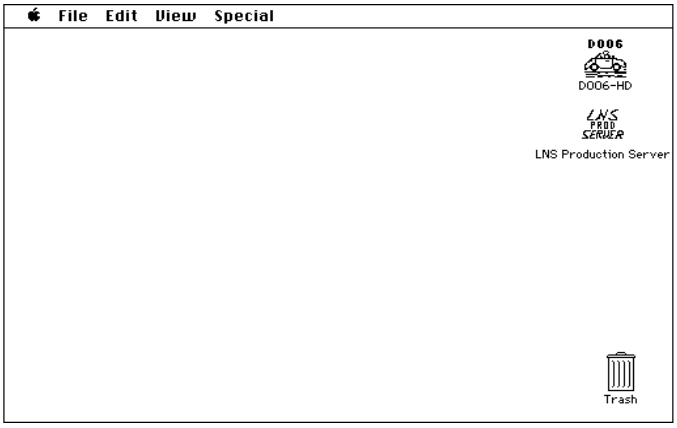


Figure 3

7.25.5 Double click on the “EOD VDA” folder (see figure 4).

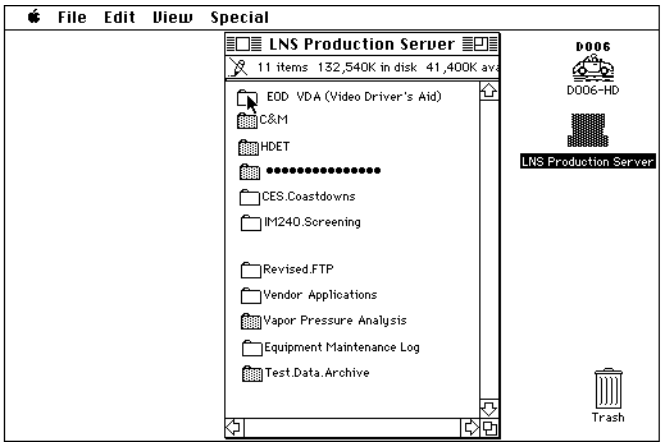


Figure 4

If an incorrect folder is opened, position the mouse pointer on the “Close” box in the upper left corner of the window and click to close it. Position the mouse pointer on the correct folder and double click on it.

7.25.6 Double click on the “C&M Diagnostic” folder (see figure 5).

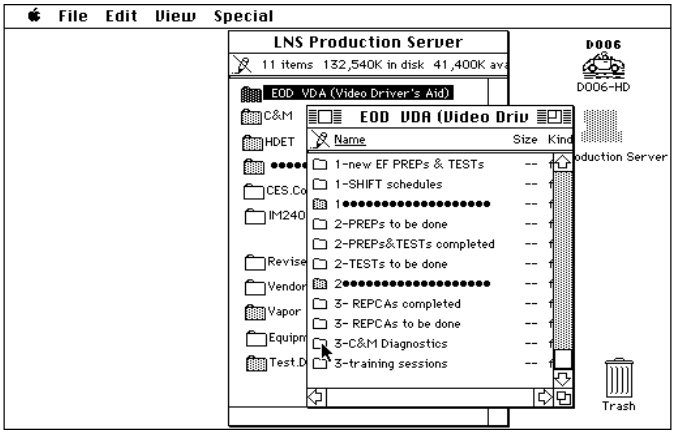


Figure 5

7.25.7 Double click on the “Ramp-Up-Down master” folder (see figure 6).

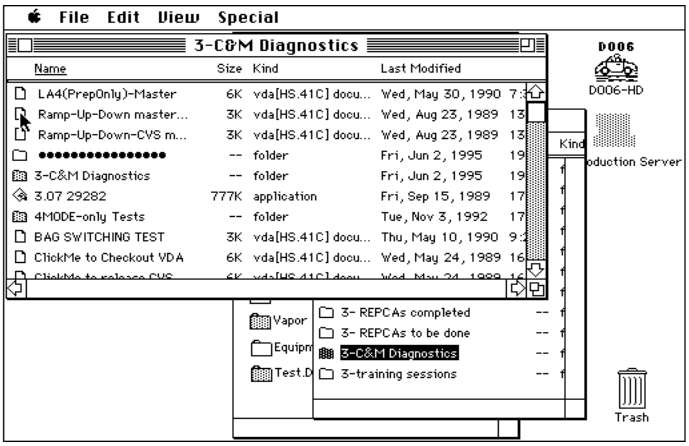


Figure 6

7.25.8 Click on the “OK” button for the dialog box that has the message, “The document “Ramp-Up-Down master copy” is locked; you will not be able to save any changes.” (see figure 7).

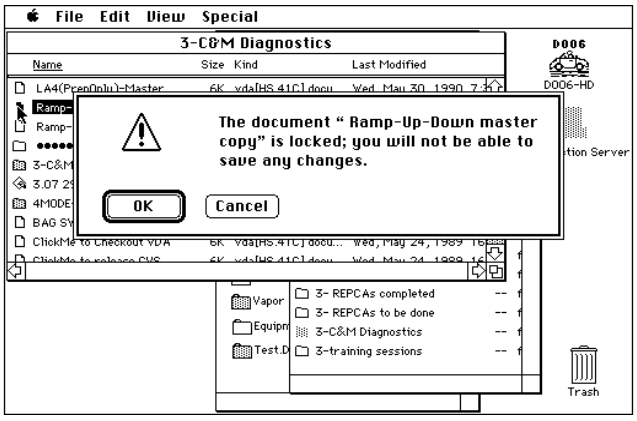


Figure 7

7.25.9 Click on the “OK” button for the dialog box that has the message, “An empty Test Schedule file name has been renamed! This file will be opened as: untitled” (see figure 8).

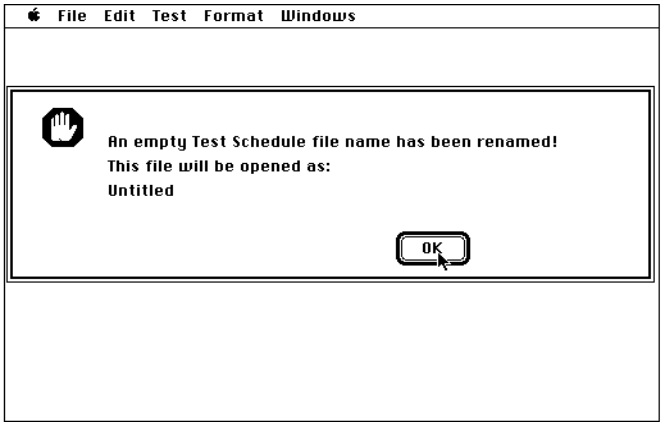


Figure 8

7.25.10 The message, “Please wait while test # is being expanded” will momentarily appear on the VDA screen.

If the warning “Dyno interface device is off, inoperative, or missing” (see figure 9) appears on the screen, contact the Computer Room for assistance. If the message displayed in figure 9 does not appear, click on the “OK” button.

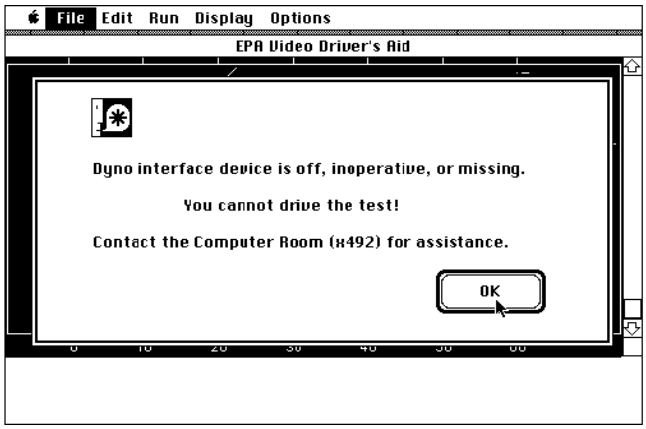


Figure 9

7.25.11 Click on the “OK” button of the “VDA - Test Information Entry” screen (see figure 10).

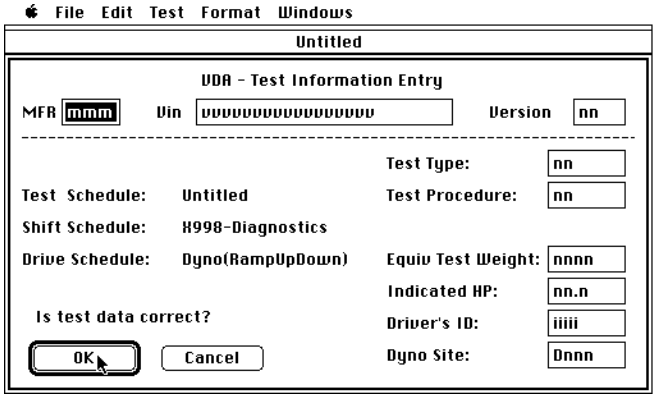


Figure 10

7.25.12 Respond to the message, “Please save this untitled test #” by entering the correct dyno number in the “D00#” field under the “Save as which file?” header (see figure 11). Click on “SAVE.”

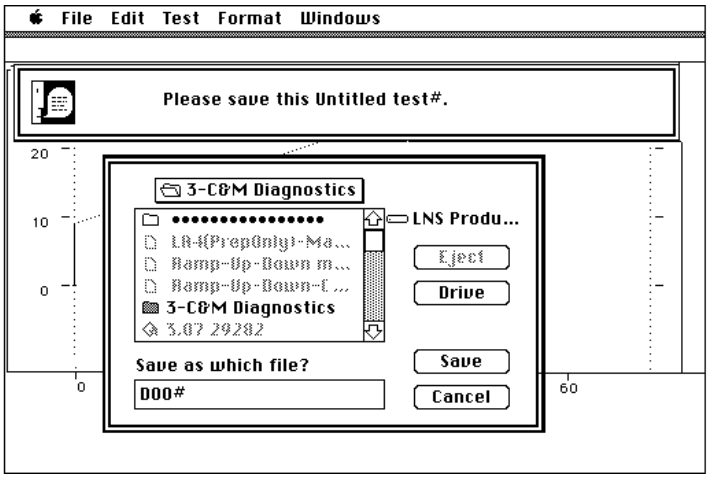


Figure 11

7.25.13 Respond to the message, “Replace existing D00#?” by clicking on “Yes.”

7.25.14 Select “Test” on the VDA menu bar and, while pressing the mouse button, drag down until “Set up for Driving" is highlighted. This will initialize the ramp-up/ramp-down profiles (0-60 @ 2.5 mph/sec separated by a 1-minute cruise at 60 mph) on the VDA (see figure 12).

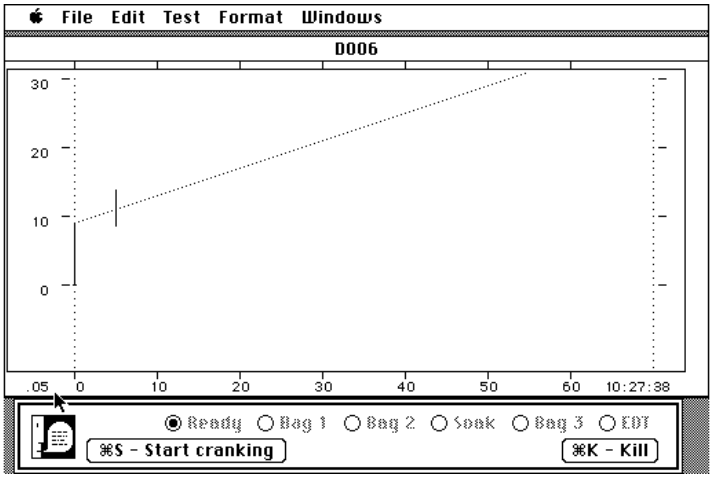


Figure 12

8. Test Procedure

Four inertia weights are verified twice a month: the 2875 and 2000 weights the first and third weeks of the month, and the 6500 and 3000 weights the second and fourth weeks of the month. The horsepower (hp) and rear roll (RR) friction are verified weekly. The rear roll and VDA speed are checked monthly.

100 Dyno Warmup

101 On the dynamometer ARLC, ensure that the IW is set to 6875 and the thumbwheel (TW) is set to 10 hp.

102 Accelerate the vehicle to 50 mph and maintain this speed while performing Steps 103-204 to warm up the dyno’s “Power Absorption Unit” (PAU) and flywheel bearings.

200 60-Tooth Gear Check

201 On the coastdown computer "Dyno Verification" screen, click on the arrow next to "60 Tooth Gear check." 60-tooth gear check operations will be performed within the highlighted "60 Tooth Gear Check" portion of the coastdown computer front panel display. The torque, speed, and time counts will be automatically recorded by the LabVIEW program.

202 On the master coastdown timer, set the 60-tooth gear manual/auto switch to "Manual."

203 On the master coastdown timer, change the speed input from "Dyno" to "60 Tooth Gear Check."

204 While maintaining a front roll (FR) dyno speed of 50 ±0.1 mph, put the master coastdown timer count/stop switch in the "Count" position. Observe the horsepower reading displayed on the Clayton Hp meter. When approximately 10 seconds has elapsed, put the count/stop switch in the "Stop" position.

205 On the master coastdown timer, change the speed input switch from "60 Tooth Gear Check" to "Dyno" and the manual/auto switch from "Manual" to "Auto."

206 On the coastdown computer "Dyno Verification" screen, click on "HP @ 50" and, in the "HP @ 50" field, use the keyboard to enter the horsepower meter reading obtained in Step 204.

207 Look at the "QC check" field and verify that the message displayed is "SPD OK;TORQUE OK;IHP OK."

If the "QC check" field indicates the speed, torque, or horsepower check is out of tolerance, click on the coastdown computer "RESET" button and repeat Steps 204 - 207.

If you are unable to obtain an acceptable "QC check" field message after the second attempt, notify the C&M senior technician.

208 Stop the vehicle.

209 Remove the "60-Tooth Gear" and the associated key from the dyno shaft with the T-Handle hex wrench, disconnect the clip from the roll cage. Return the items to the vehicle trunk.

300 Rear Roll and Video Driver's Aid Speed Checks

The “Rear Roll” and “Video Driver's Aid Speed” checks require a calibrated multimeter set to measure dc voltage on the 20-volt scale.

301 Plug the multimeter leads into the “Rear Roll” jack on the side of the ARLC.

302 Turn the multimeter power on. The meter display should indicate 0.000 ±0.002 volt. If not, contact the C&M senior technician.

303 Locate the stroboscope and position the flasher unit to point at the dyno rear roll on the driver's side of the vehicle.

304 Connect the stroboscope power plug to a 110-volt ac outlet, turn on the power switch, allow a minimum of 1 minute for warmup, and verify operation of the flasher unit.

If the stroboscope flasher unit does not function, notify the C&M senior technician.

305 Adjust the flasher unit control knobs to obtain 1943 on the display. This flash rate corresponds to a roll surface speed of 50 mph.

306 Accelerate the vehicle and observe the dyno rear-roll strobe pattern. When the rear roll appears stationary, the dyno speed is 50 mph. Maintain this speed.

307 Verify that the multimeter reads 5.000 ±0.002 volts. If not, repeat Steps 306 and 307 one more time. If the multimeter does not read 5.000 ±0.002 volts after the second attempt, stop the vehicle and contact the C&M senior technician.

308 Using the strobe indicator, maintain a dyno speed of 50 mph and look at the speed reading in the lower left corner of the VDA display. The reading should be 50.0 ±0.2 mph. If it is not, repeat this step one more time. If the reading is not 50.0 ±0.2 mph after the second attempt, stop the vehicle and notify the C&M senior technician.

309 Stop the vehicle.

310 Turn off the stroboscope power, unplug the power cord, and return the stroboscope to the vehicle.

311 Disconnect the multimeter from the ARLC.

400 Dynamometer Warmup Coastdowns

401 On the coastdown computer "Dyno Verification" screen, click on the arrow next to "Warmup Coastdowns." The arrow in the black square in front of the "•T1" counter field will initialize. Warmup coastdown operations will be performed within the highlighted "Warmup Coastdown" portion of the coastdown computer front panel display. The coastdown computer will automatically record the coastdown time for each run. Each coastdown time should be approximately 31 seconds.

402 On the master coastdown timer, verify that the speed input switch is set to "Dyno" and the manual/auto switch is set to "Auto."

403 Verify that the Dyno IW is set to 6875.

404 Ensure that the master coastdown timer speed gate selector is set to "45" for the "Low-Set" and "55" for the "High-Set."

405 Set the ARLC "TW" equal to the "TW" data displayed on the coastdown computer screen.

406 On the coastdown computer "Dyno Verification" screen, click on the "RESET" button to ensure the selected "•T1," "•T2," or "•T3" counter field is reset to "0." If this condition does not occur when the "RESET" button is clicked, notify the C&M senior technician.

407 Accelerate the vehicle to 60 mph.

408 Press the PLC "LIFT" button and allow the dyno to coast down below 45 mph. The timer will automatically stop counting at 45 mph.

409 Press the PLC "LOWER" button.

410 On the coastdown computer, select the next numbered coastdown by clicking on the black square in front of the "•T1," "•T2," or "•T3" counter field." An arrow will appear in the black square in front of the selected counter field.

411 Repeat Step 407 - 410 until the first three coastdowns are completed.

If coastdown number 4 or greater is being performed, go to Step 412 following each additional coastdown.

412 Look at the coastdown computer "QC Check" field. If the difference (max.-min.) of the last three consecutive coastdown times does not exceed 0.3 seconds, a "MAX-MIN OK" message will be displayed indicating the dynamometer is stable and the inertia coastdowns may begin.

413 If the difference (max.-min.) of the last three consecutive coastdown times exceeds 0.3 seconds, return to Step 406 and perform additional coastdowns until three consecutive coastdowns comply with the tolerances specified in Step 412. Notify the C&M senior technician.

414 Stop the vehicle.

500 Dynamometer Ramp-up/Ramp Down

501 On the coastdown computer "Dyno Verification" screen, click on "Ramp-Up/Ramp-down." Ramp-up and ramp-down operations will be performed within the highlighted "Ramp-up/Ramp-down" portion of the coastdown computer front panel display. The coastdown computer will automatically record the data.

502 Engage the dyno roll brake.

503 On the dyno, select the 4000-pound IW.

504 Push the "Preload" button on the ARLC.

505 While the light is flashing, set the "TW" to 10.0 on the RLPC. Ensure that the "TW" is set during the flashing light sequence; if it is not set during this period, press the "Preload" light again and set the "TW" while the light is flashing.

If the light either fails to flash or will not stop flashing, notify the C&M senior technician.

506 Release the dyno roll brake while the light is flashing.

507 On the master coastdown timer, verify that the speed input switch is set to "Dyno" and the manual/auto switch is set to "Auto."

508 Position the VDA monitor and keyboard for easy access from vehicle driver's seat.

509 Set the master coastdown timer speed gate selector to “5” for the “Low-Set” and “55” for the “High-Set.”

510 On the VDA, start the ramp sequence by clicking on "Start Cranking."

511 When ready to start the VDA Ramp-Up/Ramp-Down scroll, click on “Start Scrolling.” Accelerate the vehicle so the cursor representing vehicle speed stays on the ramp trace within ±2 mph of the trace at any point in time. When the end of the ramp-up trace is reached, maintain the vehicle at a dyno speed of 60 ±2 mph and stay within the VDA ramp trace.

512 On the coastdown computer “Dyno Verification” screen, switch to “Ramp-Down” by clicking in front of “Ramp Down.” Decelerate the vehicle so the cursor representing vehicle speed stays within ±2 mph of the ramp trace.

513 Look at the “QC check” field, verify that the message displayed is “SPD OK;TORQUE OK;IHP OK.”

If the “QC check” message indicates an out-of-tolerance condition, repeat Steps 510 - 512.

If the “QC check” message indicates an out-of-tolerance condition after the second attempt, stop the vehicle and notify the C&M senior technician.

514 On the master coastdown timer, set the “Low-Set” speed gate selector to “45.”

515 Look at the VDA screen and click on “OK” when the message, “Unable to caretize and Rename driven TLOG file: D00#” appears.

516 Stop the vehicle.

600 Dynamometer Timed Coastdowns

601 Click on the coastdown computer “Timed Coastdowns” arrow. Dynamometer coastdown operations will be performed within the highlighted “Timed Coastdowns” portion of the coastdown computer front panel display. The first required “IW” row will automatically be highlighted. The coastdown computer will automatically record the coastdown time from the master coastdown timer and compare it to the time from the “Quick Check Timer.”

602 On the coastdown computer "Dyno Verification" screen, click on the up/down arrows next to "IW" until the specified inertia weight is displayed. Inertia weights are selected to correspond to the full weeks of the month as follows:

2875 and 2000 weights for the first and third weeks.

6500 and 3000 weights for the second and fourth weeks.

604 On the master coastdown timer, verify that the speed input switch is set to "Dyno" and the manual/auto switch is set to "Auto."

605 Verify that the master coastdown timer speed gate selector is set to "45" for the "Low-Set" and "55" for the "High-Set."

606 Ensure that the vehicle is not moving, engage the dyno roll brake, and select the required "IW" on the ARLC.

607 Set the ARLC "TW" to correspond to the "TW" data displayed on the coastdown computer screen.

608 Release the dyno roll brake, open the roll cage, and turn the dyno rolls with your foot to verify that the correct inertia weights are engaged. If they are not, notify the C&M senior technician.

609 Accelerate the vehicle to a dyno speed of 50 ±0.1 mph as indicated on the speed meter. On the coastdown computer "Dyno Verification" screen, double-click under "Hp @ 50" and use the computer keyboard to enter the Indicated Horsepower (IHp) from the dyno speed/power display box.

610 Use the vehicle to accelerate the dyno to 60 mph.

611 On the coastdown computer "Dyno Verification" screen, click on the "RESET" button and verify that the "•T QCCDT" timer is set to zero. If it is not at zero, notify the C&M senior technician.

612 Press the PLC "LIFT" button and maintain dyno speed until the tires clear the rolls, then release the vehicle accelerator pedal.

613 Allow the dyno inertia weights to decelerate through the “55-45” speed interval.

614 On the coastdown computer “Dyno Verification” screen, double click on the “•T QCCDT” box and use the computer keyboard to enter the time from the “Quick Check Timer.”

615 Look at the “QC check” field and verify that the message displayed is “(TW - HP @ 50SS) OK;DIFF(M - T) OK;DIFF(M-QCCDT)OK.”

If the “QC check” message indicates an out-of-tolerance condition, notify the C&M senior technician.

616 Press the PLC “LOWER” button and bring the vehicle to a complete stop.

617 On the coastdown computer “Dyno Verification” screen, click on the next inertia weight and repeat Steps 606-614. The coastdown computer will automatically select the required second “IW.”

618 Look at the “QC check” field, verify that the message displayed is “(TW - HP @ 50SS) OK;DIFF(M - T) OK;;DIFF(M-QCCDT)OK.”

If the “QC check” message indicates an out-of-tolerance condition, notify the C&M senior technician.

619 Press the PLC “LOWER” button and bring the vehicle to a complete stop.

700 Dynamometer Rear Roll Check

701 On the coastdown computer “Dyno Verification” screen, click on “Rear Roll Check.” Rear Roll Check operations will be performed within the highlighted “Rear Roll Check” portion of the coastdown computer front panel display.

702 Change the front/rear roll switch to the “Rear Roll” position on the dyno speed/power display box.

703 On the master coastdown timer, verify that the speed input switch is set to “Dyno” and the manual/auto switch is set to “Auto.”

704 Verify that the master coastdown timer speed gate selector is set to “45” for the “Low-Set” and “55” for the “High-Set.”

705 On the master coastdown timer, change the front/rear roll switch to “Rear roll.” Use the vehicle to accelerate the dyno to 60 mph.

706 On the coastdown computer “Dyno Verification” screen, click on the “RESET” button.

707 Press the PLC “LIFT” button and coast down the rear roll until the counters on the coastdown computer stop.

708 Lower the vehicle by pushing the PLC “LOWER” button and bring the vehicle to a complete stop.

709 Look at the “QC check” field and verify that the message displayed is “REAR ROLL OK.”

If the “QC check” message indicates an out-of-tolerance condition, notify the C&M senior technician.

800 Data Processing

801 When all data are verified, click on the “SAVE” button on the coastdown computer front panel. Data will be saved in two archives, the Dyno Archive file located on the coastdown computer hard drive and the “DynoVer” file in the Butler ® database located on the procedure network AIS hard drive.

802 Double click on the “PROCESS DATA” icon on the coastdown computer front panel to process the dynamometer verification data.

Open the Excel spreadsheet “Dyno Checker” to process the data. Along the left margin of the worksheet are buttons that represent the Clayton dynamometers in the lab. Clicking on a button will process the last Dynamometer Verification performed on the dynamometer selected.

The coastdown computer will retrieve the data from the Butler database, plug it into the Excel spreadsheet, perform the necessary calculations, and print the “Dynamometer Calibration Verification Report” (see Attachment B) on a printer designated by the Macintosh “Chooser”.

803 Verify that the printed data agrees with the Excel spreadsheet on the coastdown computer front panel. If they do not agree, notify the C&M senior technician.

804 Close all files and shut down the coastdown computer, or close all Excel files and perform other Dyno Verifications by returning to the LabVIEW Dyno Verification program.

900 Vehicle Removal

901 When all the criteria in Sections 9, 10, 11, 12, and 13 have been met, remove the vehicle from the dyno site as follows:

If the dynamometer does not meet all acceptance criteria, it must be "Tagged-Out" of service by hanging an out of service tag on the inertia weight selector knob (See TP 204B.)

Disconnect the vehicle exhaust system from the floor exhaust dump.

Move the cooling fan(s) out of the way.

Disconnect the restraint system, including wheel chocks, from the vehicle.

Turn off the "MECO" brake switch.

Disconnect the compressed air line from the vehicle.

Retract the lift pads to a minimum of 6 inches from the floor.

Turn off and unplug the UPS.

Disconnect the data acquisition wire.

Engage the dynamometer roll brake.

Drive the vehicle off the dyno.

902 To shut down the VDA, press "File" in the VDA menu bar and drag down to "Quit."

903 Click on "No" when "Do you want a hard copy of the Summary Report ?" appears on the VDA screen.

904 Click on the close boxes of all open VDA folders.

905 Press “Special” in the VDA menu bar and drag down to “Shut down.”

906 Turn the VDA video monitor power switch off.

907 In the control room, turn off the “Computer Hard Disk” drive and “Macintosh Computer” power switches.

9. Data Input

Unless otherwise noted, the following coastdown computer data entries and selections are performed by the technician performing the calibration verification procedures.

9.1 The dyno being checked is selected in the “Dyno Verification” screen, “Dyno” field.

9.2 The “Tech ID” is selected on the “Dyno Verification” screen.

9.3 The IW is selected in the “Dyno Verification” screen, “IW” field.

9.4 For the 60-tooth gear check, the torque, speed, and time counts are automatically recorded by the LabVIEW program.

9.5 The horsepower meter reading from the Clayton Hp speed meter is entered in the “Dyno Verification” screen, “HP @ 50” field.

9.6 The coastdown computer automatically records the coastdown time for each run.

9.7 For the dyno warmup coastdown checks, the ARLC “TW” is set equal to the “TW” data displayed on the coastdown computer screen.

9.8 The coastdown computer automatically records the ramp-up/ramp-down data.

9.9 For the timed coastdown checks, the coastdown computer automatically records the time from the master coastdown timer and compares it to the “Quick Check Timer.”

9.10 For the timed coastdown checks, the IHp from the dyno speed/power display box is manually entered in the “Dyno Verification” screen “Hp @ 50” field.

9.11 For the timed coastdown checks, the time from the “Quick Check Timer.” is manually entered in the “Dyno Verification” screen, “•T QCCDT” field.

10. Data Analysis

The flow chart in Attachment C illustrates data processing, storage, and retrieval. All manual entries and quality control (QC) flags on the coastdown computer front panel are verified and corrected by the technician as the procedure is performed.

10.1 The “Date” and “Time” settings are verified.

10.2 “RRFHP Cal” is calculated on the “Dyno Checker” spreadsheet when the report is generated. The last four months of RR coastdown data are retrieved and averaged, and appear on page 2 of the “Dyno Calibration Verification Report” as “FHP Cal.”

10.3 For the 60-tooth gear check, the “Dyno Verification” screen “QC check” field message, “SPD OK;TORQUE OK;IHP OK.” is verified.

10.4 For the dyno coastdown checks, the “Dyno Verification” screen “QC check” field message, “MAX-MIN OK” is verified indicating the difference (max.- min.) of the three coastdown times does not exceed 0.3 seconds.

10.5 For the ramp-up/ramp-down checks, the “Dyno Verification” screen “QC check” field message, “SPD OK;TORQUE OK;IHP OK” is verified.

10.6 During the timed coastdown check for the first “IW,” the “Dyno Verification” screen “QC check” field message, “(TW - HP @50SS) OK, DIFF (M - T) OK” is verified.

10.7 During the timed coastdown check for the second “IW,” the “Dyno Verification” screen “QC check” field message, “(TW - HP @50SS) OK, DIFF (M - T) OK; AVG DIFF OK” is verified.

10.8 During the dyno rear roll check, the “Dyno Verification” screen “QC check” field message, “REAR ROLL OK” is verified.

10.9 The printed Excel spreadsheet information is verified to coincide with the Excel spreadsheet on the coastdown computer front panel.

10.10 The coastdown computer automatically verifies that all of the acceptance criteria of Section 12 are met as the procedure is performed.

10.11 Any data that does not meet the acceptance criteria are automatically flagged by the “Dyno Verification” program.

11. Data Output

11.1 The following two-page report is printed and the data is stored in the dyno archive file:

Page 1: Data Echo Report

Page 2: Verification Report.

11.2 A copy of the report is forwarded to the Quality Control group, the C&M senior technician, and C&M.

11.3 The results are available for statistical and graphical analyses in the Butler Data Base.

12. Acceptance Criteria

The "QC check" messages on the "Dyno Verification" screen are checked by the technician responsible at the time the procedure is performed.

If the acceptance criteria cannot be met , the dynamometer is immediately removed from service and may not be used until C&M has resolved the problem and verified the acceptability of the dynamometer.

12.1 Coastdown time must be within its target time by ±1.0 seconds. Any value outside these limits must be reconfirmed by the technician performing the verification.

12.2 IHp @ 50 mph must be less than or equal to ±0.2 hp of the thumbwheel setting.

12.3 The difference between ramp-up and ramp-down must not exceed 1 mph, 1 ft-lb, or 0.4 hp.

12.4 The front roll speed calibration must agree within ±0.2 mph of the 60-tooth absolute measurement.

If the speed calibration is acceptable, the torque and hp differences from theoretical must be ±1 ft-lb and ±0.4 hp, or approximately ±4%.

12.5 The RR FHp value must not be greater than 0.300 FHp.

12.6 For timed coastdowns, the average of the differences between the times on the master coastdown timer and the site quick-check timer for the first and second IW must be within ±0.1 second.

12.7 The rear roll and VDA speed zero and span voltage values must be within plus or minus 0.002 volts of the 50 mph value.

13. Quality Provisions

13.1 The timed coastdowns are monitored by the Quality Control Group for trends and offsets.

If a significant offset is noticed, QC immediately brings it to the attention of C&M, which must take corrective action to restore the central tendency of the data to near the zero line.

If the four-month average of the verification coastdowns exceeds ±0.5 seconds, C&M will investigate the trend.

13.2 The difference (max.-min.) in warmup coastdown times must not exceed 0.3 seconds.

13.3 The data for each dynamometer are presented at the weekly Repeatable Car (REPCA) meeting and priorities for corrective action are set at that time. Any outstanding deviations are also discussed.

13.4 Corrective actions are reviewed and approved by the C&M senior technician before the dyno site is released for testing. Verbal notification of approval is made to the VT senior technician. A written description of the corrective action is recorded in the Facility Support Branch (FSB) log.

13.5 If a dynamometer has undergone repair, this procedure or applicable portions of it are performed on the dynamometer to determine if it still meets the acceptance criteria for testing.

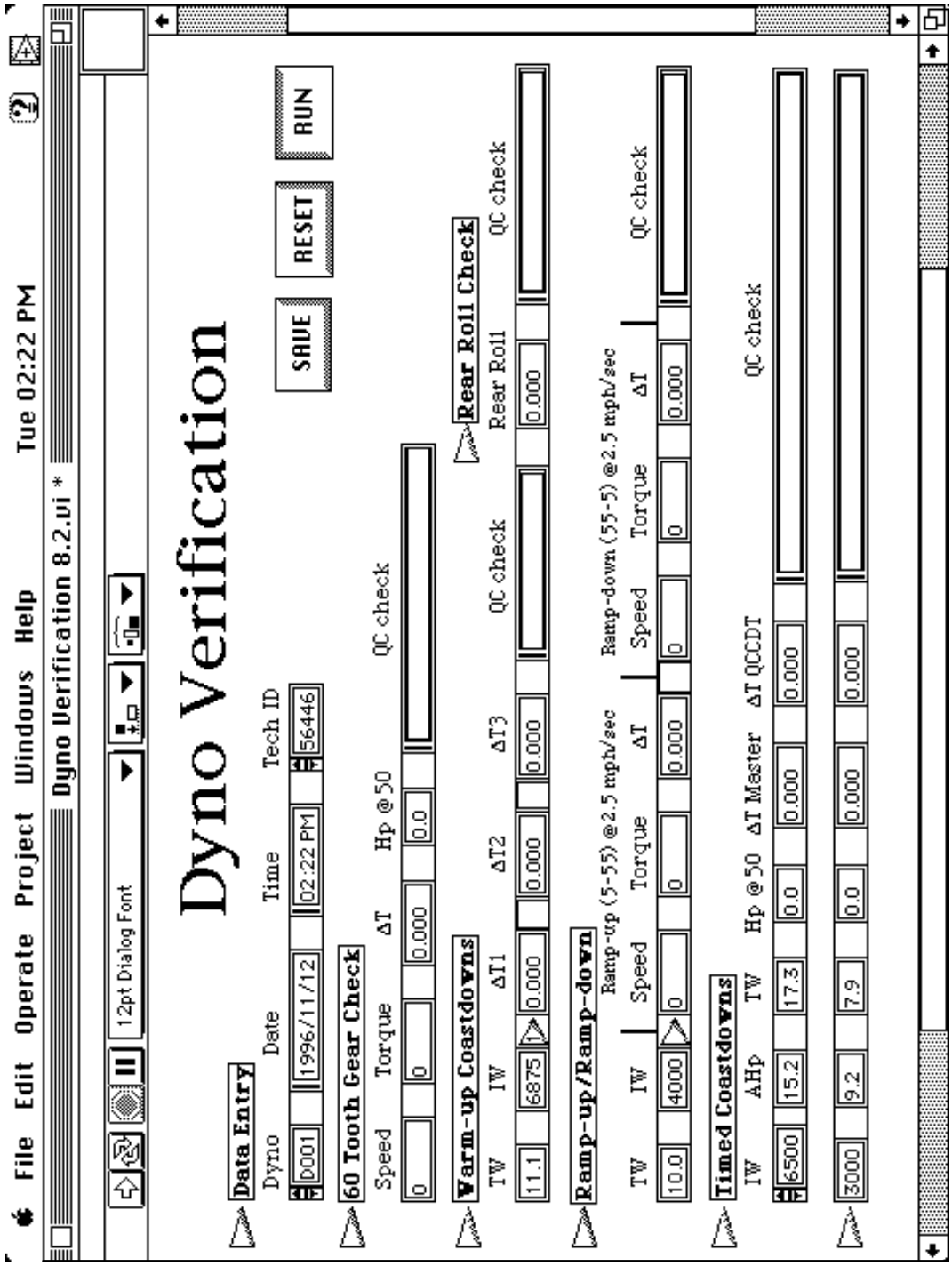
13.6 All coastdown computer entries are verified for completeness and any QC flags addressed. Data not collected are zeros or are left blank.

13.7 The coastdown computer automatically verifies that all of the acceptance criteria of Section 12 are met as the procedure is performed.

13.8 Any data that does not meet the acceptance criteria are automatically flagged by the “Dyno Verification” program.

13.9 Any dynamometer not meeting the acceptance criteria will be tagged “out of service.”

Attachment A



Attachment B

DYNAMOMETER CALIBRATION VERIFICATION
INPUT DATA
SITE: D003 DATE: 05/28/96

General Information	Site	Date	Time	I.D.
	D003	5/28/96	8:17	36561

Speed Check TW=10.0
60 Tooth Gear
@ IW=6875

Gear Counts	Torque Counts	Delta t	IHP	FHP Cal
20022	10249	10.321	10.0	0.153

Warm-up Coastdown	TW	IW	Delta t1	Delta t2	Delta t3	Delta t(RR)
	10.2	6875	32.004	32.084	32.071	71.119

Speed Torque PAU Hysteresis	TW	IW	Ramp-Up @ 2.5 mph/sec (5-55 mph) Gear Counts	Torque Counts	Delta t	Ramp-Down @ 2.5 mph/sec (55-5 mph) Gear Counts	Torque Counts	Delta t
	10.0	4000	23159	8897	19.524	23110	8710	20.137

Verification Data	IW	AHP	TW	HP @ 50 SS	Master Delta t	Quick Check Delta t
	6500	19.8	16.7	16.8	20.313	20.240
	3000	9.2	7.4	7.3	20.304	20.240

Dynamometer Calibration Verification Report
Site: D003 Date: 05/28/96

Date: 05/28/96

Operator ID: 036561 Dyno Site: D003

Processed: 06/24/96 16:06:25

All data and results have been verified for correctness and acceptability

Verified by: _____

File one copy in the diagnostics documentation file and distribute the others.

PAU Hysteresis Check 2.5 mph/sec IW=4000 TW=10.0

	Speed	Torque	IHP
Ramp-up	30.524	12.317	2.782
Ramp-down	29.533	11.691	2.555
Diff	-0.992	-0.626	-0.227
Average	30.029	12.004	2.669
Theoretical	30.000	12.000	2.664
Diff(A-T)	0.029	0.004	0.005
% Difference	0.095%	0.037%	0.172%

Warm-up Coastdown Tw=10.2 Iw=6875

Delta t1	32.004
Delta t2	32.084
Delta t3	32.071
Max-Min	0.080
Mean	32.053
St Dev	0.043
%CV	0.134%

Rear Roll Coastdown Iw=155

Delta t	71.119
FHP CHK	0.132
FHP CAL	0.153
DEL FHP	-0.021
%DEL FHP	-13.492%

50-mph Speed Check TW=10.0, 60-Tooth Gear

	Speed	Torque	IHP
Measured	49.92	26.84	10.0
Target S	50.00		
Theor. t		26.94	10.0
Diff	-0.08	-0.10	0.0
% Diff	-0.16%	-0.38%	0.5%

Quality-Control Comments (Refer to TP-302A Criteria)

(#1 QC CHECKS NOT EXCEEDED.)
(#2 QC CHECKS NOT EXCEEDED.)
(#3 QC CHECKS NOT EXCEEDED.)
(#4 QC CHECKS NOT EXCEEDED.)
(#5 QC CHECKS NOT EXCEEDED.)
(#6 QC CHECKS NOT EXCEEDED.)
(#7 QC CHECKS NOT EXCEEDED.)

Dynamometer Verification Data

IW	AHP	TW	HP @ 50 SS	Master Delta t	QCheck Delta t	Difference Delta t	Theoretical Delta t	Difference Master - Theoretical	% Difference Master - Theoretical
6500	19.8	16.7	16.8	20.313	20.240	-0.073	19.937	0.376	1.888%
3000	9.2	7.4	7.3	20.304	20.240	-0.064	19.803	0.501	2.529%
					Averages	-0.069		0.439	2.208%

Attachment C

Dynamometer Verification Data Processing Flowchart